



Thyroid Metabolic Hormones, Parathyroid Hormone & Calcitonin

We know that Thyroid Gland is located below the Larynx and it secretes three Hormones. **Thyroxin** also called **T4** and **Triiodothyronine** called **T3** and **Calcitonin**. We will talk about the Thyroid metabolic Hormones which are: **T4** and **T3**.

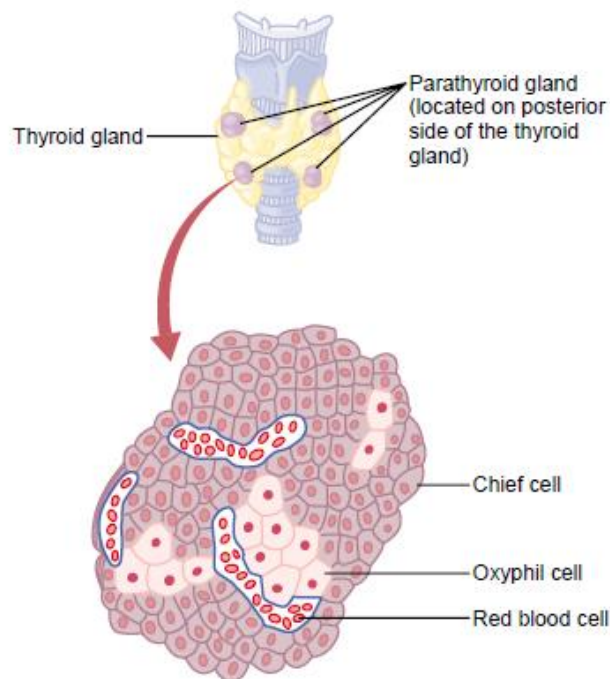


Figure 79-9

The four parathyroid glands lie immediately behind the thyroid gland. Almost all of the parathyroid hormone (PTH) is synthesized and secreted by the chief cells. The function of the oxyphil cells is uncertain, but they may be modified or depleted chief cells that no longer secrete PTH.

93% of the secretion is **Thyroxine** and the rest is **Triiodothyronine T3**. The function of the two hormones is the same the difference is that **T3** is more powerful than **T4** and **T4** is converted in the tissues to **T3**. For the normal synthesis of thyroid metabolic hormones Thyroid gland needs **Iodine** in small percentage approximately **1mg/week**.

Thyroid metabolic hormones are regulated by **TSH** (Thyroid Stimulating Hormone) called **Thyrotropin** secreted by the **Anterior Pituitary Gland**. Also **TSH** is regulated by **TRF** (Thyrotropin Releasing Factor) from the **Hypothalamus**.

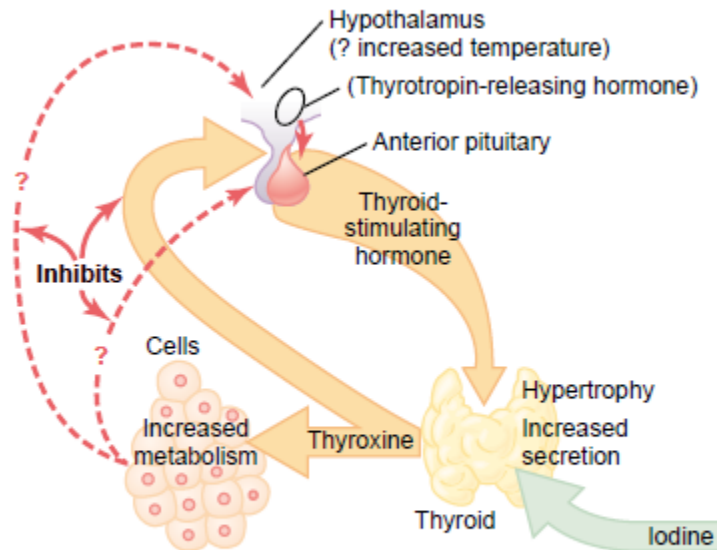


Figure 76-7

Regulation of thyroid secretion.

Some factors stimulate Thyroid Hormone secretion example:

- The Cold stimulate **TRF** secretion by the Hypothalamus so it will increase **TSH** release and increase release of Thyroid Hormones.

On the other hand some factors decrease **TRF** secretion example:

- Emotional reactions such as **Anxiety** and **Excitement** these emotional factors decrease **TRF** secretion.

The function of Thyroid Metabolic hormones general function is **increase the rate of metabolism → increase carbohydrate metabolism → increase fat metabolism → increase protein metabolism**.

Important note: in fat metabolism and the effect of thyroid hormones it is found that thyroid hormones increase the secretion of **Cholesterol** into the Bile so it can be lost in stool. The mechanism of this the thyroid hormone increases the number of **Low-density**

Lipoproteins receptors in liver cells so it will happen rapid removal of Lipid from the blood so secretion of **Cholesterol** into the bile and then can be lost in stool.

If there is **Hypothyroidism** what will happen to lipid concentration in blood? It will happen increase in the Lipid concentration in blood in **Chronic Hypothyroidism** especially **Cholesterol** which might lead to **Atherosclerosis**.

In **Hyperthyroidism** there will be decrease in Lipid concentration in blood.

Another important function of Thyroid Hormones is **Promotion of Skeletal Growth in children** so it may happen in those who have **Hypothyroidism** → retardation of skeletal growth. In contrast those who have **Hyperthyroidism** it may lead to → excessive skeletal growth. But most important is that thyroid hormones are important for the growth and development of the **Brain** during fetal life and the first few years after birth so if **Hypothyroidism** occurs in this period it will lead to **Cretinism** which is characterized by failure of skeletal growth and mental retardation.

Also another effect of Thyroid hormones example:

- Concerning **Cardiac output** if there is **Hyperthyroidism** the rate of metabolism increases and if the rate of metabolism increase → oxygen will decrease → CO₂ and other vasodilator substances increase which will lead to → Vasodilation → increase blood flow → increase venous return → increase **Cardiac output**.
So **Cardiac output** can increase in **Hyperthyroidism** and decrease in **Hypothyroidism**.
- In **Hyperthyroidism** the **Heart rate** increases because thyroid hormones increases the excitability of the heart so the **Heart rate** increases in **Hyperthyroidism** and is considered one of the major symptoms in **Hyperthyroidism**.
- Concerning effects of thyroid hormones on **Respiration**. In **Hyperthyroidism** the **Respiratory rate** will increase because the rate of metabolism increased and the oxygen is decreased and increase in CO₂ so → activation of **Respiration** will occur.
- The effect of thyroid hormones on **Gastrointestinal or Digestive system**. In **Hyperthyroidism** the motility increases and the secretion also increases in which will lead to → Diarrhea.
In **Hypothyroidism** it will lead to → constipation.
- Concerning the effects on **Central Nervous System**. In **Hyperthyroidism** the sensitivity of neuronal synapses will increase so in these patients it may happen **Extreme nervousness** it may lead sometimes to **Psychoneurosis**. Also in these patients there is **Insomnia**. In contrast in **Hypothyroidism** the patient is calm (**Somnolence**) sleepy.

- Other sign in **Hyperthyroidism** is **Fine Muscle Tremor**. We can observe this condition by placing a sheet of paper on the extended fingers and we will observe **Vibration** of the paper. This will indicate that there is **Fine Muscle Tremor**.
- Thyroid Hormones are important for **Normal Sexual Function**. In **Hypothyroidism** whether in males or females it will occur **Loss of Libido**. In **Hyperthyroidism** it will occur in some males **Impotence**. Also in females in **Hyperthyroidism** or **Hypothyroidism** it may occur disturbance of **Menstruation** (Menstrual cycle).

In figure 76-8 the patient has **Hyperthyroidism** and she has **Exophthalmos**.

Exophthalmos occurs because of degeneration of Extra-ocular muscles and swelling of the retro-orbital tissues.



Figure 76-8

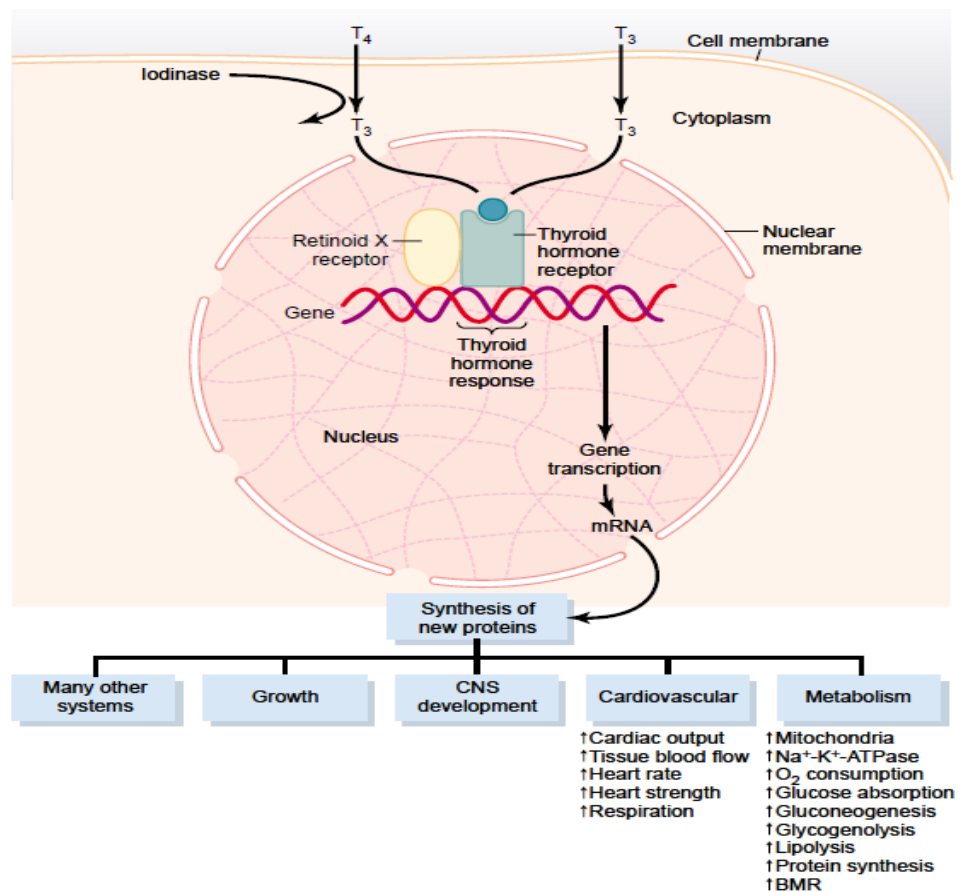
Patient with exophthalmic hyperthyroidism. Note protrusion of the eyes and retraction of the superior eyelids. The basal metabolic rate was +40. (Courtesy Dr. Leonard Posey.)

In figure 76-9 the patient has **Hypothyroidism** we will observe swelling of the face we call it **Myxedema**. Formation of some substances such as **Hyaluronic acid** and other substances that bound to proteins so increase formation of **Tissue jell** which will lead to this type of edema → **Myxedema**.



Figure 76-9

Patient with myxedema. (Courtesy Dr. Herbert Langford.)



Parathyroid Hormone

There are 4 Parathyroid glands they are found behind the Thyroid gland. Essentially Parathyroid hormone is related to calcium. The normal concentration of Calcium is **8.5 – 10.5 mg/dl**. Calcium is found in ECF in three forms:

- 41% of this Calcium is bound to proteins so it is **non-diffusible** through the capillary membrane.
- 9% is not bound to plasma proteins it can **diffuse** through the capillary membrane but it binds to other substances like phosphate so it is **Not Ionized**.
- The remaining 50% of Calcium is **diffusible** and **ionized**. The Ionized calcium is the important and which enter in many functions of calcium like **Blood clotting**, **Muscle contraction** and **Bone formation** and others.

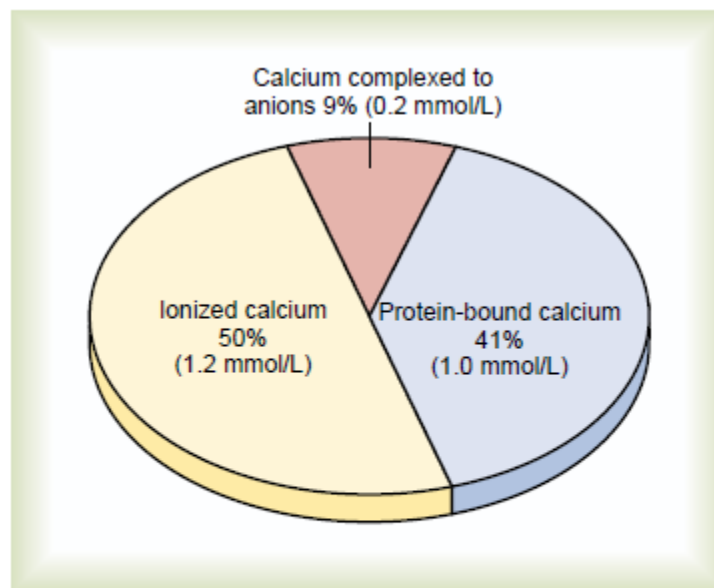


Figure 79-1

Distribution of ionized calcium (Ca^{++}), diffusible but un-ionized calcium complexed to anions, and nondiffusible protein-bound calcium in blood plasma.

Parathyroid Hormone **increases calcium** and **decrease phosphate** → **increase calcium** because it increases absorption of calcium salt from the bone and **increase renal reabsorption of calcium**. Parathyroid Hormone also increases absorption of phosphate from bone so why decreases phosphate? Parathyroid hormone **decreases renal reabsorption of phosphate**.

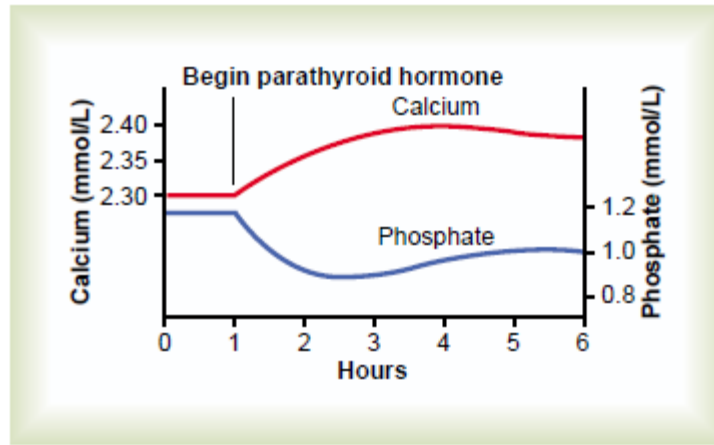


Figure 79–10

Approximate changes in calcium and phosphate concentrations during the first 5 hours of parathyroid hormone infusion at a moderate rate.

Another important thing is the relation of Parathyroid hormone with **Vitamin D**. Normally in the skin there is a substance considered as a pro-vitamin **7-dehydrocholesterol** this substance is exposed to irradiation by **Ultraviolet** rays from the sun and converted to **Vitamin D3** or **Cholecalciferol** this is not the active form of **Vitamin D** so it must be activated in two sites in the body:

- Activation occurs in the liver **Cholecalciferol** is converted to **25-hydroxycholecalciferol**.
- Activation occurs in kidney **25-hydroxycholecalciferol** is converted to **Calcitriol** or **1, 25 dihydroxycholecalciferol** this is the active form of **Vitamin D**. This activation that occurs in kidney requires **Parathyroid hormone**.

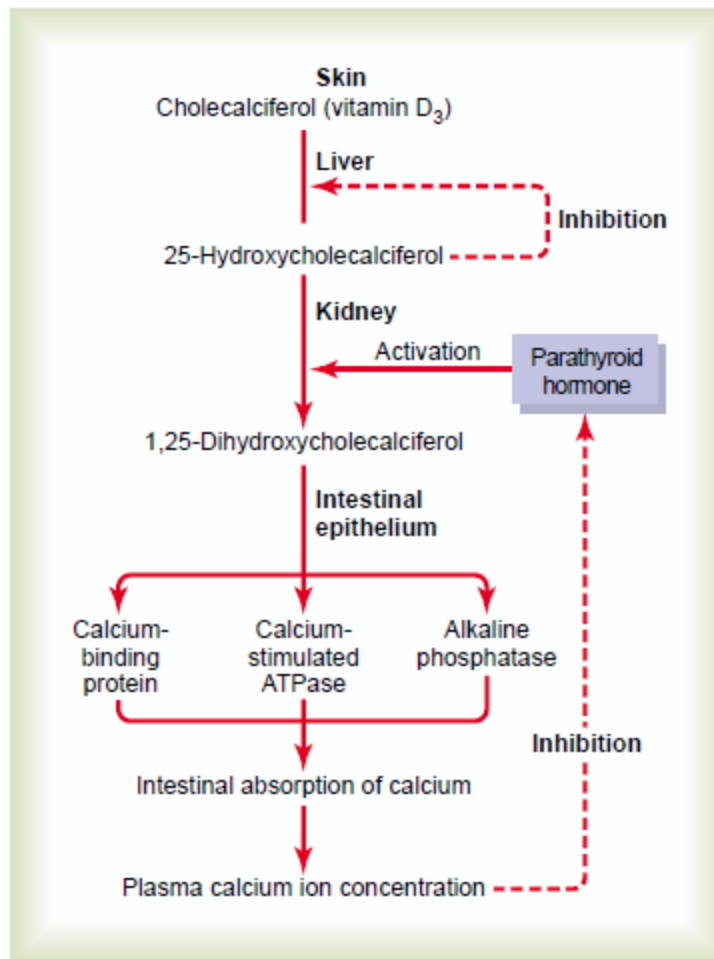


Figure 79-6

Activation of vitamin D₃ to form 1,25-dihydroxycholecalciferol and the role of vitamin D in controlling the plasma calcium concentration.

Vitamin D increases intestinal absorption of calcium and help also in calcium reabsorption in Kidneys. It is important for the development of bones that is the formation of bone matrix and calcification of bone by **increasing the activity of Osteoblasts**. But an important note in the effect of **Vitamin D** higher concentrations of this vitamin causes an inverse action → increasing the activity of **Osteoclasts** which will digest the Bone matrix and dissolution of calcium salts so → release of calcium into the blood.

The Bone is composed of organic matrix and calcium salts. The major percentage is for calcium salts it represents 70% of the bone.

It may occur calcification of bone by the calcium salts that are found in plasma especially **calcium phosphate compound**.

Precipitation of **calcium phosphate compound** normally occurs in bone but it may precipitate in other tissues. They found that concentration of these **calcium salts** in the

blood is considered big and if we look for the needs for them in deposition of calcium salts in bones they are supersaturated.

Why calcium phosphate is not precipitated in other tissues than bone in normal conditions? The reason is that there are **inhibitors** for this precipitation in other tissues except bone and one of these **inhibitors** is **Pyrophosphate**.

But it may occur precipitation in abnormal conditions like what happen in arterial walls in case of **Arteriosclerosis** or in **Old blood clots** or in **Kidneys**. In these abnormal cases it occurs **disappearance of these inhibitors** and also may occur degeneration of tissues which will lead to precipitation of **calcium salts** in these abnormal conditions.

Calcitonin

It is secreted by the thyroid gland but it has relation with calcium. Parathyroid increases absorption of calcium but **Calcitonin** is different it **decreases the high concentration of calcium toward normal** by increasing deposition of calcium in bone and also can decrease renal reabsorption of calcium.

How Calcium Ion concentration is regulated against change in Ca^{+} ion:

- The first line of defense is not hormonal. **Exchangeable calcium salts** in bone these **Exchangeable calcium salts** are loosely bound in bones so if there is increase in the calcium in the blood it will happen deposition of calcium salts and in contrast if there is decrease in the calcium in blood it will occur absorption of these calcium salts from the bones also there a proportion of **Exchangeable calcium salts** in mitochondria of liver and intestine.
- The second line of defense is hormonal if Calcium Ions increases. Parathyroid hormone decreases and vice versa. **Calcitonin** will increase.

Some of the effects of **Hypocalcaemia** is the excitability of the nervous system will increase so it will occur continuous discharge of the peripheral nerve fibers → it will lead to **Tetanic muscle contraction (spasm)**.

One of the forms of **Tetany** in hand is **Carpopedal spasm** also in severe cases of **Hypocalcaemia** it may occur **Epileptic seizures** because of the over-excitability of brain cells. The major risk if the **Tetanic or spasmic contractions** occur in the laryngeal muscles which will lead to **Asphyxia** and **Death**.



Figure 79-2

Hypocalcemic tetany in the hand, called carpopedal spasm.

In **Hypercalcemia** the nervous system is depressed → the Nervous reflexes becomes low → the **QT interval** decrease in **Hypercalcemia** if you remember in Cardiovascular system the QT interval is the period of contraction of the ventricles 0.35 sec. It decreases because the contractility of the heart decreases → also it may occur constipation because of decrease contractility of the GI tract → also it may occur precipitation of calcium salts if there is **Hypercalcemia**.

هذه الملخصات هي منكم. عن اجتهاد شخصي لمجموعه من طلاب الطب البشري /عدن معتمدين
على عدة مصادر مما تم محاضراته او قراءته ..وقد تفيد البعض منكم .وللعلم ليس لها اية علاقة مباشرة
بأي عضو من اعضاء الهيئة التعليمية في الكلية. *زملائنا الاعزاء إن أصبنا فمن الله ، و إن أخطأنا فمن
أنفسنا و من الشيطان " نبقى بشرا نخطئ و نصيب فلذا يرجى الإشعار في حالة وجود اي ملاحظات
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